Editorial

Telemedicine: An Application in Search of Users

Telemedicine involves the use of telecommunication technologies as a medium for the provision of medical information and services to consumers at sites that are at a distance from the provider. The concept encompasses everything from the telephone system to high-speed, wide-bandwidth transmission with use of fiberoptics, satellites, or a combination of terrestrial and satellite-communication technologies. The peripheral software could be as simple as a typewriter used to type a letter requesting an opinion or as complex as high-capacity parallel processing computers and imaging devices. Although the definition includes telephone, facsimile, and distance learning, the term "telemedicine" is currently used as a generic label for remote consultation and diagnosis. Telemedicine is not a medical subspecialty but a facilitator of all medical and surgical specialties.

Potential Scope.—Although telemedicine dates back to the 1950s, this phenomenon is currently being embraced enthusiastically by telecommunications specialists, hardware and software manufacturers, medical-care providers, policy makers, and politicians alike.[1-3] The potential scope of telemedicine is vast. With only a few exceptions, most existing medical disciplines can be practiced by using telemedicine methods. The proponents of telemedicine believe that, in addition to providing specialty care for isolated communities, telemedicine can provide universal access to high-quality medical care at an affordable cost.

Existing telemedicine applications can be classified into two categories: (1) remote diagnosis and consultation, primarily between a specialist and another health-care provider such as a primary-care physician, nurse practitioner, or other allied health provider, and (2) distance learning for continuing education. Future applications would include administering therapeutics remotely, such as "telepresence" and "telesurgery." Extensive use of powerful computers, virtual reality, and high-speed, reliable communications network with protocols such as asynchronous transfer mode (ATM) on synchronous optical network (SONET) backbones would make this a reality. "Beam me up, Scotty" would not be a metaphor that would be relegated to movies and television but could be used in the practice of medicine as well.

Primary Rationale.—The primary rationale for development of telemedicine has been to serve those populations that, for various reasons, have limited access to traditional, high-quality medical services. Such populations include those living in rural areas or other underserved areas similar to that reported by Kottke and associates in this issue of the *Mayo Clinic Proceedings* (pages 329 to 337). Many chronic medical conditions (for example, hypertension, diabetes, heart disease, and arthritis) have a higher prevalence in such populations, as does the rate of death from accidents.[4] Additionally, the geographic distribution of health-care providers, driven largely by economic and cultural factors, further compounds the problems faced by the rural and underserved residents. A combination of all these factors makes telemedicine an attractive complement to whatever health-care services may be available in these areas.

A question that should be asked is whether the published literature supports the use of telemedicine as a safe, medically effective modality. A technology that fails to meet this basic criterion should not be used. To date, no comprehensive evaluation of an integrated telemedicine system has been published. The literature, however, does document the feasibility of telemedicine,[5] which is further substantiated by the current study by Kottke and colleagues. In this telemedicine project, Kottke and coworkers demonstrate that this mode of delivery is indeed acceptable to not only most patients but also the health-care providers. Moreover, they also demonstrate a seamless integration between terrestrial T-1 lines and an Advanced Communications Technology Satellite (ACTS) low-data-rate earth station, which in itself was a challenge until this project. With advances in technology and "on-demand" bandwidth, the economics may tilt in favor of using telemedicine for routine clinical practice. What are lacking are studies of medical effectiveness and cost-effectiveness for telemedicine.

Practical Guidelines.—The following lessons have been learned in the context of using telemedicine.[5-9]

1. The needs of the population or community that is being served should be carefully evaluated before determining the level of service, which will dictate the technology that needs to be deployed. "One size fits all" is not applicable to telemedicine.

2. Having an electronic environment in place, including electronic medical records, is critical if this type of health-care delivery is to be viable. As emphasized by Kottke and associates, physician time can be used efficiently if the data are available in a collated, organized manner; thus, the satellite time can be limited to face-to-face consultation, rather than searching for pertinent data.

3. Telemedicine should not be expected to replace existing health services but should supplement or complement what is already available.

4. In order for telemedicine to be successful, it must be an integral part of the strategic plan for the enterprise and not a series of demonstration projects.

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5. Demonstration projects must determine cost-effectiveness and outcomes and not simply the capability of the technology.

6. Despite promises of solutions created by technology, social, ethical, and professional issues can affect telemedicine. Considerations must include legal ramifications of telemedicine, issues of licensure, and development of standards delineating acceptable quality for practice.

7. The cost of telecommunications must be drastically reduced if this modality is to be economically viable. Technologies such as ACTS that permit on-demand use of bandwidth and deregulation of telecommunications will help to reduce the cost of telecommunications services.

8. The quality of health care provided should not be compromised. Hence, drastic, lossy compression of video images should not be permissible. By use of destructive compression algorithms, the cost of transmission can be decreased, but this mechanism compromises the quality of images and leads to a lower level of diagnostic accuracy.

9. Adherence to standards—for telemedicine practice, telecommunications, data transmission, and computing in medicine—is important.

Applications at Mayo.—Telemedicine at the Mayo Clinic evolved for a specific reason: to facilitate integration of group practice at three distant locations—in Jacksonville, Florida, Scottsdale, Arizona, and Rochester, Minnesota. In 1986, Mayo Foundation installed a satellite-based, analog video system that enabled physicians, researchers, educators, and administrators to communicate with each other. A fully functional three-way system was in place, making telemedicine an everyday possibility. Because of the growth in number of specialists at all these locations, this system is being increasingly used for education, research, and administrative purposes. With the expansion of regional practices around all three locations and the need for connectivity for patient care, we continue to explore new, improved, and cost-effective methods for providing this link and expanding it to other locations in the United States and other countries.

The article by Kottke and colleagues explores the use of a new satellite (ACTS) for providing remote diagnostic and educational services. The second phase of this project involves use of very high rates of data transmission (155 megabits/s) in applications requiring real-time, high-speed, wide-bandwidth transmission modes such as cardiac catheterization, echocardiography, and telemedicine consultations using multimodality imaging techniques for assessment of patients with congenital heart disease. This project, which is supported by the National Aeronautics and Space Administration (NASA) and the Advanced Research Projects Agency (ARPA), explores the combination of satellite-communication and terrestrial services for telemedicine and attempts to characterize an economic telemedicine model.

In addition to these on-demand, face-to-face consultations, the project will explore the feasibility of "store and forward" telemedicine consultations in cardiology, orthopedics, dermatology, and endocrinology. The economic model for such consultations and their outcomes will be studied. Electronic records will be incorporated, for further reinforcement of the conclusion reached by Kottke and colleagues that not all ailments require real-time face-to-face consultation. For successful conduct of the high-data-rate ACTS-ARPA project, Mayo has assembled a consortium of leaders in the industry (Hewlett-Packard, General Electric Medical Systems, Sprint, U. S. West, Martin Marietta, Healthcom, and Good Samaritan Hospital in Arizona), in addition to Mayo Foundation entities. The results from this project will help determine a strategic policy for telemedicine at Mayo Clinic, in addition to providing knowledge about use of ATM technology for local area and wide area networks.

Conclusion.—In general, the use of telemedicine in day-to-day practice remains limited. Although much is claimed, the benefits of telemedicine—economic and otherwise—remain to be proved. Nevertheless, the use of telemedicine will continue to become more widespread in the days that follow. The critical success of telemedicine will depend, ultimately, not on the legal, ethical, or economic issues but on the acceptance of this modality by health-care providers and patients and the demonstration of improved patient outcomes with the use of this mode of health-care delivery.

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